ENGINEERING NEWS.

Tribune Building, New York City.

GEO. H. FROST, PROPRIETOR.

SATURDAY, ARPIL 2, 1881.

WORK has been commenced upon the New York side of the Hudson River Tunnel at the foot of Morton street. After the shaft shall have been sunk, a diaphragm will be built across it at the top of the tunnel entrances, in order to secure a large and safe working chamber. We will publish a detailed account of this portion of the work as soon as the final plans will have been adopted.

Engineering for 1880 is out of print, and odd numbers can with difficulty be bought. Having mutilated our file of last year we are willing to supply odd numbers at *fifty cents each* to parties wishing to obtain them. We have two years of *The Engineer* unbound that we will sell at $5 each year of two volumes.

NOTWITHSTANDING the increase in price of this journal, the unusually large increase in new subscriptions has exhausted the earlier numbers of the volume, and, unless we can buy some of them back, we cannot fill any more orders for the complete volume of this year. At present we will give *one month's subscription* for each of the first two numbers of the year. We are short of numbers Seven and Ten, and for the purpose of evening up our files will pay *ten cents* each for them. The present rate of increase in our subscription list will soon exhaust all our back numbers, and we therefore wish to call the attention of subscribers to the impossibility of our supplying any missing numbers a while hence. We cannot supply Nos. 1 and 2 except with the full volume. We have still odd numbers of volumes 6 and 7, which we will send to any address at ten cents each.

THE economic necessities of Europe, which are an outgrowth of the increase of population on the one hand, and of American competition on the other, will soon give an immense impetus to engineering works. The waste lands must be reclaimed; rapid and cheap transit must be assured, but this latter will be more by water ways than by land travel, and will be of such a nature as almost to change the geographical appearance of countries. The canals which are now projected in Germany will unite historic rivers and will bring into closer communication countries which have been separated by "mere accident of surface." And here it might be asked how far the engineer is going to replace the statesman and the political economist, the preacher and the journalist. England and France will soon be united by a tunnel; the Alps are pierced—the armies of the future will no longer march "up the mountain" as in Napoleon's time—the military engineer assumes a greater importance than ever. The civil engineer is looked forward to as the righter of Nature's caprices, as the only help in time of economic trouble. The Gotthard and the Arlberg tunnels will be completed within a few years, but this very fact will make another tunnel necessary for the interests of French trade. The Simplon tunnel, which has been under discussion during the last thirty years, was to be brought up in the French Chambers this week, the Mont Blanc project having apparently been abandoned.

A certain feature of railroad enterprise in Europe at the present time is the number of "direct" lines between places which were at one time at least considered as of secondary importance. Thus a direct road is to be built between Berne and Neufchatel, and many of the smaller French towns are being connected by secondary lines. The increase of the population in European cities, though slow, is continous, and will necessitate additional roads. In this country, however, the rapid growth of cities and whole districts, will make new and unthought of lines the essentials of prosperity. Whether our rapid transit lines may not one day do on a large scale for the great Oriental trade what they are now transacting for rich and rare freight—as silks, cocoons, etc.—is a question which rates of freight and increased consumption will very soon determine, and that before the Panama Canal is finished. Should this overland transit trade be secured, the railroad system of the United States would assume vaster proportions. Steamers are now driving out sailing vessels from the Pacific, so that the contest would be simply one between steam on sea and steam on land.

PERSONAL.

Horatio Seymour, Jr., New York State Engineer and Surveyor, is stopping at the Buckingham Hotel, this city.

On the 28th ult. Gen. U. S. Grant started for Mexico, to be gone about four weeks. He goes in the interest of the Mexican Southern Railroad, of which corporation he is President.

Theodore F. Wurtz Consulting Engineer, of Atlantic City, N. J., left on the 29th ult. for Florida, to be absent about three weeks on a brief reconnoissance of the country between the Gulf of Mexico and Lake Okeechobee, for the Okeechobee Land and Improvement Company.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.*

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page* 121.)

V.—BOSTON.

The city of Boston is in lat. 42° 21′ 27.6″ N., long. 71° 3′ 30″ W., on the west side of Massachusetts Bay at the mouth of the Charles River.

The old town, founded in 1630 and incorporated as a city in 1822, is on a peninsula of irregular shape and surface, four-fifths of it less than 20 ft. above tide level, the rest rising in one or two places to 100 ft. By the annexation from time to time of adjoining towns the city now comprises an area of 30 square miles of irregular form, being about 13 miles long and 8 miles wide in extreme dimensions. There are 360 miles of streets.

In 1652 "The Water-Works Company" was incorporated for building "the Conduit" which was a reservoir about 12 ft. square to which water was conveyed from neighboring wells and springs.

A frame building over it was used for storage, but was afterwards removed and the conduit roofed over. Though serving a temporary purpose this never satisfied the expectations of its projectors, and all vestiges of it have long since disappeared, though its site is marked on a map of 1722.

On June 10th, 1796, the population being about 21,000, "The Aqueduct Corporation" was chartered, a private company with a capital of about $130,000 with the right to procure and distribute water, the price of water furnished to be regulated by the Legislature, and Boston and Roxbury to have hydrants for fire purposes. The water was brought from Jamaica Pond, about 5 miles in bored logs of 4 and 5 in. diameter, with very curious contrivances at the points of junction of branches.

In 1835 Loammi Baldwin, C. E., examined into the practicability of increasing the supply. The water was conducted to a reservoir in Boston which was 21.58 ft. deep, the bottom being 29.44 ft. below the outlet at the pond. This reservoir was used for some years, but was discontinued for several years prior to 1880.

* Copyright 1881.

The amount of water furnished is not known In 1822 the pond fell below the outlet for a few weeks but in the succeeding 11 years the surface averaged 5.22 ft. about the outlet.

There were in 1845 3,500 families supplied from this source, the charge being from $10 to $15 per annum according to the size of the family.

The supply was insufficient for the growing city, and in 1835 there were 2,767 wells in use, 33 of which were artesian, but out of the whole number only 7 furnished water soft enough to use for washing. In 1840 there was great complaint of the deficiency of wells, and in one case it was stated that "a well from which many drew their water. was kept locked except at certain hours, and people could no more get water except during the hour that the box was kept open, than they could procure discount at one of the banks of the city out of banking hours."

For fire purposes 56 reservoirs were in use at that time, holding 300 to 400 hogsheads each, some containing rain water and some salt water drawn from the harbor, but it was complained that this was offensive, very destructive to goods, and ruined the clothing of the firemen. The shipping was supplied from Roxbury by private persons at an annual cost of about $6,000.

After a long and acrimonious controversy and exhaustive examinations by engineers, the construction of works to supply the city by gravity from Long Pond was begun in 1846, John B. Jervis, C. E., being Consulting Engineer, and E. S. Chesbrough and William S. Whitwell the Chief Engineers of the two divisions in which the work was arranged, one being the lake, conduit, and receiving reservoir, the other the distribution service and reservoir.

On October 14, 1848, water was introduced into the city from Long Pond, since and now called Lake Cochituate.

Lake Cochituate has a water-shed of 18.87 square miles and an area at full water level of 800 acres. It is in three natural basins, respectively 72 ft., 50 ft., and 64 ft. deep, connected by narrow channels in the lower of which provision is made for shutting off the water by stop plank, thus retaining the water of the two upper basins in case repairs are needed to the dams.

When drawn down 10 ft., or to the level of the flow line of the conduit, the area is 489 acres.

There are two dams, both of granite masonry and 500 ft. apart. The high-water mark of the reservoir is 134.36 ft., and the bottom of the conduit at the dam, 121 ft. above tide level.

The cause of the construction of the secondary dam was the fact that the first dam was on quicksand, and after filling the lake, springs boiled up below it carrying sand. The lower dam was protected by a line of 8-in. tongued and grooved sheet piling driven 15 to 20 ft. in the gravel.

Near this lake are Dug Pond, of 44.5 acres, and Dudley Pond, of 81 acres, which have been connected with the lake by pipes. In making the Dudley Pond connection in 1861, by an 18 in. iron pipe, it was necessary to cut 60 ft. deep through an embankment.

Pegan Brook, flowing through the village of Natick, discharged offensive matter into the lake, and in 1863 a filter dam was built across the meadow at its mouth, consisting of coarse stone, except 3 ft. in the centre which was of fine pebbles. This worked satisfactorily.

The aqueduct is oviform, with the large end down, 6.33 ft. high and 5 ft. wide. The bottom is a semicircle of 2.5 ft. radius. It is built of brick 8 in. thick, plastered outside from the top to the spring of the invert. It rests on earth throughout, the foundation on embankments being puddled. Generally it is in excavation, the cut being in some places more than 30 ft. There are two tunnels on the line. The gradient is $\frac{3}{4}$ inches per

mile, except at the crossing of the Charles River, which is effected by an inverted syphon of 2 cast-iron pipes of 30 in., and one of 36 in. for 1095 ft., with a fall of 0.52 ft. between the ends.

In the total length of 14.627 miles the fall is 4.26 ft.

At the approach to the river it is carried on a granite bridge of 80 ft. span, and then for some distance on a puddled embankment 40 ft. high across the Charles River; the syphon pipes are carried on a granite bridge of 3 elliptical arches of 30 ft. span and 7.5 ft. rise, the aqueduct being 71 ft. above the river and 52 ft. below the ordinary grade line.

Cracks occurred in the aqueduct on embankments from time to time. On March 29th, 1859, at the westerly end of the Charles River syphon, a break occurred carrying the gate house, 100 ft. of the conduit and several iron pipes into the river, which was entirely dammed up by the débris for a short time. The water was shut off from the conduit within two hours after the accident, which was supposed to have been caused by a leak in one of the pipes.

It occurred on a Tuesday morning. By nine o'clock on Saturday night one line of pipe was restored and in nine and a half days from the break the whole work was restored.

The mean annual rainfall at the lake is 49 in. and the yearly flow is equivalent to 22 in. The average daily yield of the Cochituate water-shed has been 20.5 million gallons, ranging from 13 to 42 millions. The distribution of the rainfall has been such that in no case has it been possible to utilize more than 21 million gallons per day.

The capacity of the reservoir is 6 in. on the water-shed. The amount of storage capacity necessary to utilize all the rainfall which flowed into the lake would have been 18 in., taking a series of years.

In 1875 another 40 inch syphon pipe was laid across Charles River, to increase the delivery of the conduit. The new chambers were placed 75 to 100 ft. farther from the river than the old ones. To build them a section of the conduit was stripped of earth and supported by chains from over-head beams, and the masonry of the chambers built to inclose the sections, which were afterward cut out. The conduit ran full while while this work was going on and the water was shut off only one day while cutting out the sections.

The conduit was originally intended as a channel, but as early as 1856 was run part of the time under a head, and has been so used for several years now.

During January, 1871, the lake was drawn down so low that steam pumps were placed in the gate-house and water pumped into the conduit. The lake was drawn down to only 9 in. above the conduit bottom.

In January, 1875, it was similarly lowered to 9½ in. below the bottom of the conduit.

Under the advice of Joseph P. Davis, C. E., a temporary supply was obtained from the Sudbury River by a dam across that stream at a point where its bed is composed of a layer of sand and gravel 2 to 3 ft. thick, underlaid by a stratum of fine sand. Three rows of sheet piling were driven across the stream. The bed of the river was covered with a floor of closely laid planks about 30 ft. wide, on which were placed strong frames of timber 6 ft. apart across the river, the spaces being filled with stop planks 4 in. thick and 8 ft. high, the width of overfall being 120 ft. Three rows of round piles were driven 10 to 12 ft. into the bed of the river, to which the flooring and frames were secured.

This dam turned the river into the outlet of Farm Pond, which was widened and deepened. From the other end of the pond a canal was cut through a low divide to another brook leading into Lake Cochituate, the channel of the brook being widened and deepened. This temporary water course was about 4 miles long altogether. It was completed in June 1872, and was used when additional supply was needed until the completion of permanent works for additional supply.

These permanent works were built after the plans of Mr. Davis. The supply is drawn from the Sudbury River, which has a drainage area of 78.24 square miles.

Three dams placed at the confluence of two streams form a triangle of reservoirs, the water of any one of which can be drawn directly to the conduit. The dams are of earth, with heart walls of stone masonry. The overfalls are in the middle, and are of cut-stone masonry.

A conduit, 4,000 ft. long, carries the water thence to Farm Pond, a natural lake of 200 acres area.

The Sudbury conduit, from Farm Pond to Chestnut Hill reservoir, is 16 miles long and has a grade of 1.056 ft. per mile. In section it is on top a semicircle of 9 ft. diameter. The bottom is an arc of 13.22 ft. radius, struck from a centre 5.55 ft. above the crown of the arch, and the side walls are arcs of 9 ft. radius struck from the covering arch and intersecting the bottom invert. The sectional area is 56.75 sq. ft. The foundation is of concrete, the side walls and spandrill backing of rubble-stone masonry, the lining of brick 4 in. thick, and the arch of brick 12 inches thick.

When above the natural surface, it rests upon carefully compacted embankments of selected earth.

The Charles River is crossed on a granite bridge 475 ft. long and 75 ft. high, with one segmental arch of 130 ft. span and 69 ft. radius, five semi-circular arches of 37 ft. span and one segmental arch of 28 ft. span. The side walls above the conduit bottom are of brick. The Waban Valley is crossed by a bridge 536 ft. long and 40 ft. high, of granite, with nine semi-circular arches of 44.67 ft. span, surmounted with brick walls inclosing the conduit. Spaces in the side walls of these bridges are left for drainage. The inside of conduit on bridges is coated with Portland cement.

Special arrangements are made at certain points in the conduit to facilitate measurements of the flow, and since its completion the most accurate measurements ever made of the flow of water in large masonry channels have been conducted by A. Fteley, C. E., who was the engineer in immediate charge of construction of the works of additional supply.

The Sudbury conduit was first used in February, 1878. Slight cracks have occurred in the masonry, but no serious settlement.

RESERVOIRS.

Brookline reservoir, at which the old conduit terminates, has an area of 22.95 acres, a depth of 14 to 24 ft., and a capacity of 120 million gallons. The surface when full is 124.6 ft. above tide. In 1854 the water was drawn out and the banks showed a tendency to slide, which was prevented by drawing the water down slowly.

Chestnut Hill reservoir was begun in 1865 and completed in 1870. It is in two sections of irregular form. The easterly and the larger of the two basins is called the Bradlee basin. When full its water area is 87½ acres, its average depth of water 20 ft., and its capacity 550,583,485 gallons. The west or Lawrence basin has a water area of 37½ acres and a capacity of 108,888,944 gallons.

The dam of the Bradlee basin is 2,000 ft. in length, 20 ft. wide on top, and in one place 150 ft. wide at the base. The greatest height near the effluent gate-house is 35 ft. In the centre of this bank is a puddle wall 10 ft. thick at the base, and 4 ft. at the top, founded on the rock. There is a brick tooth wall in the centre 18 in. square, laid on the rock. The earth of which the banks are composed was put on in layers and well-watered and rolled. The stone lining of the reservoir is of dry rubble masonry 2½ ft. thick, extending down 8½ ft. Then there is a berme of 5 ft., and from here a stone rip-rap covers the slope.

A bed of quicksand 28 ft. in depth rendered the laying of the foundations of the effluent gate-house a difficult task. Rubble piers with brick arches rest on the bed rock. These were leveled off on top with a layer of concrete, and a heavy bulkhead, side walls brick piers and groined arches complete the remainder of the substructure. The superstructure is built of hammered granite.

Gates worked by hydraulic pumps were put in the Chestnut Hill reservoir gate-house in 1873. The openings are 48 in. square. The gates move vertically and are carried on three pairs of 12-in. wheels against the frames, but when closed the gate face and seat are in contact and the wheels lifted slightly from their tracks.

The water cylinders are of 8 in. diameter. One of these gates can be opened by one man in 3 minutes and closed without shock in 20 seconds, if desired.

The former gates required 3 men for an hour to open one.

East Boston reservoir is 322 by 150 ft. by 30 ft. deep, with capacity of 5,591,816 gallons. It always leaked and the leaks were getting to be of great importance in 1855. It leaked in 1865 when filled over 10 ft., and after experimenting two years it was repaired by removing the stone lining, covering the slopes with 18 in. of puddle covered with 1 to 3 ft. of gravel, and stone paving over that, which proved satisfactory.

It was thrown out of service in 1872, another supply for its district being furnished under greater head.

The South Boston reservoir is 21.25 ft. deep, with capacity of 7,508,246 gallons. It leaked in 1865, and for several years afterward. After 1870 it was only used for storage in case of fires, it being too high for the low service supply of its district.

Beacon Hill reservoir has masonry walls 3 to 5 ft. thick, 40 ft. high. Its interior dimensions are 167 by 162 ft. by 16 ft. deep. Its capacity is 2,678,961 gallons. In 1854 leaks in it were reported as an annoyance. In 1860 and 1861 repairs were made and the reservoir reported to be tolerably tight.

It was not used for some years prior to 1880, except as a storage basin in case of fire.

A high-service reservoir on Parker Hill, holding 7,000,000 gallons at 219 ft. above tide, was completed in November, 1874. The area of water surface is 1.47 acres.

In 1851 the city purchased the works of Jamaica Pond aqueduct for $45,000, and sold them in 1856 for $32,000, with the conditions that no water should be supplied to Boston.

A high-service supply for Roxbury was provided in 1868 by two horizontal direct-acting fly wheel engines, each with steam cylinder of 20 in. diameter and 36 in. stroke, working a pump of the same stroke and 14 in. bore, pumping into a standpipe 5 ft. diameter and 80 ft. high, inclosed in an ornamental masonry tower 170 ft. high, the base being 150 ft. above tide. South Boston was connected with the high-service supply in 1872.

The situation of Boston requires several mains across rivers.

South Boston is supplied by two siphons crossing the Fort Point channel, of 20 and 16-in. pipe laid in boxes surrounded by concrete.

East Boston is supplied by a 20-in. pipe, crossing Charles River by a siphon, then over Chelsea Bridge, where it passes two channels by siphons and crosses Chelsea Creek by two flexible-jointed pipes, 461 ft. long; one of 20 in., laid in 1848, and one 24 in. pipe, laid in 1871.

The joints are ball and socket joints, moving only in a vertical plane.

Deer Island is supplied by two 8-in. pipes, with Ward's flexible joints. They were put together on shore and hauled into place.

A leak in a 20-in. submerged pipe was stopped in 1871 by dredging away the earth and leaving the pipe exposed, showing a crack nearly half way around the pipe near a flange, which was filled with pine wedges and covered with an india rubber band secured by iron clamps to the pipe and the flange.

The work was done by a diver, and occupied three weeks.

Important changes in the distribution system were made in 1873 and 1874, to increase the circulation and supply; several miles of 6 and 4-in. pipe have been replaced by larger sizes.

Some Scotch pipe were laid in 1857, coated with Smith's preparation. The uncoated pipe previously laid were much corroded. The corrosion seemed to have been rapid at first, but gradually decreasing in energy year by year. All pipes since 1857 have been coated.

On November 9 and 10, 1872, a great fire occured, destroying an area of 60 acres. During the 35 hours of its continuance the water used was sufficient to flood the whole area to a depth of 10½ in.

In 1873 many stand-pipes, from 3 to 6 in. in diameter, connected directly with the street mains, and independent of the regular services, were put in large buildings for use only in case of fire.

TO BE CONTINUED.

We are pleased to acknowledge the receipt of a complete set of the reports of the Trustees of the Sandusky (Ohio) Water-works, and the report of Council Committee on Water-works for the City of Sandusky, from E. Graves, Superintendent of the works; report of the City Surveyor on Additional Water Supply for the City of Grand Rapids, Mich., and also a set of the reports of the City Engineer since the organization of the Board of Public Works, from A. C. Sekell, City Engineer; report of City Engineer of Boston, Mass., for the year 1880, from Henry M. Wightman, City Engineer; the History of the Water-works of Mankato, Minn., and also the Annual Water Rates, from M. B. Haynes, City Engineer; copy of *The Gate City*, of July 19, 1878, Keokuk, Ia., containing account of test of the new Holly System of Water-Works, tested July 18, 1878; eighth annual report of the Lowell Water Board to the City Council of Lowell, Mass., from Horace F. G. Holden, Superintendent.

If we should fail to acknowledge the receipt of any reports or papers which may be sent us, we hope our friends will be kind enough to notify us.

SOME NOTES ON ENGINEERING FIELD WORK.

BY WM. CAIN, C. E.

Leveling.

A design for a self-reading level rod, divided into feet and tenths, the figures showing the hundreths also, is given in an adjoining cut. It is seen that a broad line is drawn through the center of each figure to indicate the even tenths of a foot. This is not necessary when the figures are well understood, as then the exact center is seen at a glance, but as the rod should answer the requirements of the initiated or uninitiated it is best to draw the lines indicated. The fine horizontal lines between these divisions are drawn in pencil in laying off the rod, and are only shown on this drawing in order that the merit of the figures adopted may be seen.

The figures are $\frac{2}{10}$ of a foot in height, $\frac{1}{10}$ below and $\frac{1}{10}$ above the center line, there being $\frac{1}{10}$ interval between the figures.

It will be noticed that the horizontal boundary lines of the 2 and 3 show every hundreth at a glance, and that the other figures either give every hundreth directly, or by means of halveing some white or black space by the eye which is readily done. In fact the eye can quarter a space very easily, so that although this rod is only intended to read to hundreths, yet it can easily be read by the leveler at moderate distances to half a hundreth if desired. It is well known by practitioners that where the figures are of the *ordinary kind*, that a good leveler will estimate the hundreth by the eye—accurately most of the time—never erring more than a hundreth, as a target will prove; and really such leveling is, in general, sufficient for most work; even canal levels 6 miles long have been run with such rods and the surface of the water ultimately let in proved the accuracy of the work. I remember that by the use of such a rod in re-leveling over 30 miles of railroad location the result by the two lines of levels never differed more than a tenth and a half and at the last bench the difference vanished.

Similarly on lines one and two hundred miles long a corresponding accuracy has been obtained, though there is a great difference in levelers in respect to accuracy. Those men who are imbued with some pride in the correct performance of their work will keep their instruments always in order and in adjustment; will see that the level rod is held plumb, particularly on benches, and will read it twice; will put in little wooden pegs at all turning points, and try hard to equalize distances to back and fore sights, so that any error of the instrument (and there is always some error, and that changing too all day by the heat of the sun and usage) may be eliminated in the final results.

In view, however, of the fact that with rods of the ordinary construction, especially when laid off badly, errors in reading do creep in, it is certainly well to use by preference a rod that will certainly read to hundredths accurately, especially if the cost is but a trifle more. On this point I can say that I have laid off in pencil and painted a 16-foot rod of design shown, in three days or less. It is not advisable to leave the laying off to the average workman, or the rod will likely be worthless, but let the engineer do this part himself and the painting too, if a painter with a delicate hand cannot be procured.

The rod should be of light wood, white pine for instance, and painted white. To lay off the rod with the figures shown, it is best first of all to mark off the hundreths, from one end of the rod to the other by fine pencil lines, drawn entirely across the rod, by aid of a tri-square, and then to use a stencil cut out of paper to put in the oblique and vertical sides of the figures, the horizontal lines being already *accurately* drawn as above. The stencil cannot be depended on to give these last lines correctly.

The numbers 10, 11, 12, can be drawn by aid of the same stencil, by shifting it, so that the figures will be somewhat narrower than the tenth figures.

The rod can now be painted, the even feet in vermillion, the tenths in ivory black, artists' colors in tubes being used with a fine brush. If preferred, the foot-marks can be left in white, the inclosing space being in black or red. The eye can thus more readily catch the foot-marks, though the figures do not look so well.

The first rod I designed after this pattern was in 1868, the figures all being in red or white, the idea being to use such a color that the cross hairs could be seen across it, so that the reading could be more easily taken.

The "thing was too red" and indistinct, and this, combined with an inaccurate painting of the rod by a workman, who, probably, thought it a new fangled humbug only invented for his worry, tended to bring my rod into disrepute among my co-laborers. My next attempt resulted in a 16-foot rod with figures double the height of those described. Only the 2, 4, 6 and 8 were used for the tenths. This rod was intended for rapid leveling where long sights of 800 to 1,400 feet could be taken. The rod could easily be read 600 to 800 feet with a transit telescope of usual power. The only objection to this rod was its weight, for the design permitted one to read easily to hundredths for nice work. I have, a number of times, had occasion to run road lines, and even rough experimental lines, at the rate of 8 miles a day, where a rod of this description would have been a great boon. On one occasion some 11 or 12 miles, of ridge line mainly, had to be made in a day if possible. Two rods and a man to carry level were furnished me, all hands kept at a trot when moving, the instrument whirled to first one rod and then to the other, not taking time to "level up" on intermediates, and the trip was made. Accurate leveling can be done along a constructed railroad with one rod at the rate of 15 miles per day. In most cases in practice this very rapid leveling is not needed, in which case the size of the figures proposed is the best and simplest, and is the size that I have latterly used. There is no patent on this rod. One fault with most rods is that they are too short. Have the rod made as long as possible, especially for the mountains, and give it to a burly fellow to carry, dispensing, if need be, with the services of some delicate gentleman who is generally supplied the leveler, to set a target (an operation that wastes two hours per day), and to keep "a check level book."

I have never known the necessity for the latter luxury (?), when the level notes are kept as shown below, thus affording that very *double check* on the computations that experience shows to be necessary.

PAGE OF LEVEL-BOOK

Sta.	B. S.	S.	F. S.	+ —	Elev.	
B. M.	4.65	.....	.....	.....	100.00	
0	.....	5.72	.....	−1.07	98.93	15.98
1	.....	13.88	.. ..	−8.16	90.77	4.65
+40	2.21	.....	15.98	−2.10	88.67	−11.33
						2.21
						0.70
2	.....	5.61	.....	−3.40	85.27	
3	13.39	.....	0.70	+4.91	90.18	+1.51
4	.....	10.14	.....	+3.25	93.43	
5	.....	8.03	... ..	+2.11	95 54	
						13.39
						7.58
+80	.... .	7,58	7.58	+.45	95.99	+5.81
	20.25		24.26	−4.01	95.99	

By this form of level book the intermediate sights are kept in a column to themselves headed *S.*, the back sights and fore sights on turning points being placed in separate columns, marked *B. S.* and *F. S.* respectively. The "difference," or + and — column, and the elevations are made out in the usual manner. The first line of levels gives *B. S.* 4.65, and *F. S.*, 15.98; their difference, applied with its proper sign to the elevation 100, gives 88.67, as we have just found by going through the intermediates. *This is one check on the work.* The next line of levels gives (2.21 — 0.70) + 88.67 = 90.18, as found in the usual manner, and so on to the bottom of the page. If the last sight, at the bottom of the page, is an intermediate, repeat it as a *F. S.*, and treat it as such, using the same sight at the top of the next page as a back sight. This would be a true back sight if we should "turn" on this peg and the next line of levels was at the same height as the preceding, from whence the reason of the rule becomes evident.

Our next step is to add up the columns *B. S.* and *F. S.*, subtract one sum from the other, giving 4.01 in this case, and apply this difference with its proper sign to the elevation at the top of the page.

If the work is correct, it should give the last elevation 95.99, *thus affording a double check on the work*. The "intermediates" are of course right, unless opposite errors have been made, which I never knew to happen but once.

By no other form of field book can this double check be obtained so quickly and so neatly. By the "Height of Instrument" method, so warmly commended by some authors, there is no check on the intermediates at all, so that any number of them may be wrong, but the field book will not show it. In fact the very merit these authors claim for it—the successive sights *not* being bound to each other by a connected chain of differences—is the great and overwhelming defect of this "cheap John" system, which should *only* be tolerated when putting in grades on graded work, where a check is afforded. If rapid leveling is needed, the intermediates need not be worked out in the field, the differences in the readings of the turning points alone being set down in the field and the elevations carried out from them. The leveler should make it an inflexible rule to apply the second check on each page before turning to the next one.

This form of field book requires a little more computation than the popular "H. I." method, but it is more than compensated for in the superior accuracy attained, and the mental and moral satisfaction that when you turn a page you leave no errors behind you.

A word with respect to the adjustments of the level may not be out of place. There are only two essential adjustments; first, placing the horizontal hair so as to pass through the line of collimation; and, secondly, getting the level tube parallel to this line. When this is done, and the bubble is in the center, the horizontal hair being truly horizontal, the line of sight is a true level line, parallel to a tangent plane to a still lake of water, at the spot. A third adjustment, which permits the telescope to be revolved on its spindle without the bubble leaving the center, is a great convenience, as it saves a deal of "leveling up" at intermediates, but it is not essential. The above adjustments are generally made in the usual manner laid down in American manuals. Thus the second adjustment is effected by reversing the instrument in the wyes and moving the little screws at the end of the level tube until the bubble remains in the center on reversing. Now this simply insures that the line connecting the bearings in the wyes of the telescope is a level line when the bubble is in the center. It does not insure that the instrument maker has made the rings concentric with the line of collimation, without which the line of sight will not be horizontal.

To make it so in any case, and at the same time to test the accuracy of the workmanship, use the old dumpy level adjustment. Set up the level *midway* between two pegs, adjust the horizontal hair and take the rod readings on the two pegs. Their difference is the *true* difference of level of the pegs. If the instrument be moved now near one of the pegs and a rod reaching on it taken, the difference just found, added or subtracted to it, as the case may be, should give the rod reading at the other peg. The horizontal hair should be put on this reading and the level tube moved by the screws at its end until the bubble is in the center, when it is certain that the line of sight is a level line, parallel to the bubble, and the instrument is in adjustment. If the adjustment by the first detailed method has been made previously, this second method will afford the means of testing it, *i. e.*, of testing the concentricity of the telescopic bearings. It is to be observed, however, that after an instrument has been put in perfect adjustment, that it, unfortunately, will not remain so throughout the day, owing to changes of temperature and usage. Levels, however, differ very greatly in this respect, even when made out of the same sheet of brass. If an old instrument is left out of adjustment some time, so that the screws become rusted, they are very apt to work back to the old position after being adjusted again, and the instrument becomes worthless. It follows, therefore, that there is only one absolutely correct method of leveling; that is, by taking the turning points at equal distances from the level. Such accuracy is only essential for canal work, and even then if a record is kept, and the sum of the distances to back sights is made equal to the sum to fore sights, between benches, the result is generally sufficiently accurate, though if the adjustment of the level is changing materially, it is seen that this is only an approximation.

In connection with leveling, an interesting question may be asked engineers acquainted with our seaboard lines. Suppose a line of levels ran along our seaboard from New Orleans to New York, for example, the base being mean tide at New Orleans, how much will this base differ from mean tide at various points along the coast, as Mobile, Savannah, Charleston, Wilmington, Norfolk, Baltimore, etc.?

Theoretically, if levels were run on a calm sea (frozen over say), from the equator to the poles, using short sights, the surface should everywhere read zero in the level book, although we are constantly nearing the centre of the earth as we approach the poles; but the configuration of the coast, in connection with the tides, may cause a slight departure from this law along our coasts.

Barometric Leveling.

It is often desirable in making a reconnoissance, especially in the mountains, to know the heights of the various points along the route, as gaps, streams, etc., without taking time to run a line of levels. With two observers, one at the upper station, the other at the lower station, both provided with Green's mercurial barometer, and observing simultaneously, very good results may be obtained. With but one barometer, the results are influenced by the well-known fluctuations of the amosphere during the interval of the observations. The aneroid barometer, when used, should be tested at various altitudes, with a mercurial barometer, before its results can be relied on. A scale of corrections may be thus determined; but it it is very doubtful if it remains constant all the time, so that the aneroid is only to be looked upon as giving a rough means of leveling, only useful because of its portability.

The popular opinion, I infer, is that the *mercurial* barometer affords only a rough approximation to the truth in leveling.

To show how erroneous this idea is I submit the following table (taken by permission from the forthcoming volume on the "Geology of N. C.," by W. C. Kerr, State Geologist), giving the elevations above sea level of a number of stations in North Carolina, by barometer, and by the United States Coast and Geodetic Survey, using the method of triangulation.

The barometer work was done by Professors Guyot of Princeton, Kerr of North Carolina, and others. Simultaneous observations were taken by two observers, generally one or two for each station, though for Mitchell's High Peak the mean for a large number of observations was taken. The computations were based upon Laplace's formula, tables having been prepared by Professor Guyot to expedite the work, and published in the Smithsonian collection. Railroad levels were taken as a base for the barometric altitudes.

Station.	C. & G. S.	B.	Diff.
Moore	2,572	2,583	+11
King	1,092	1,650	−42
Poore	2,680	2,665	−15
Pilot	2,413	2,435	+23
Standing Indian	5,495	5,528	+33
Picken's Nose	4,910	4,926	+16
Little Bald	5,217	5,240	+23
Saddleback, or Stuly	4,563	4,506	−57
Whiteside	4,931	4,907	−24
Fodderstack or Terrapin	4,510	4,500	−10
Chimney Top	4,573	4,563	−10
Hogback	4,780	4,792	+12
Cold Mt	4,627	4,631	+ 4
Bear Wallow	4,245	4,233	−12
Sugar-loaf	3,978	3,973	− 5
Balsam	6,370	6,425	+55
Mt. Hardy	6,102	6,133	+31
Mt. Pisgah	5,713	5,757	+44
Tyron Mt	3,249	3,237	−12
Crowder Mt	1,606	1,597	− 9
Spencer Mt	1,294	1,271	−23
Silver Cr. K	2,847	2,822	−25
Hibriten	2,265	2,242	−23
Negro Mt	4,597	4,678	+81
Mitchell's High Pk	6,988	6,707	+19
Blackstock K	6,378	6,380	+ 2
Craggy Mt	6,068	6,090	+22
Little Pisgah	4,437	4,417	−20
Pinnacle	3,832	3,834	+ 2

It is seen from this table, embracing altitudes from 1,300 to 6,700 feet, a range of 5,400 feet, that the barometer is sufficiently near the truth to answer all the requirements of a reconnoissance. The results are very valuable too in demonstrating the accuracy of the formula used, any errors in the constants having a tendency to balance each other.

Transit Work.

A few remarks will be made under this head, suggesting attention to some points usually neglected.

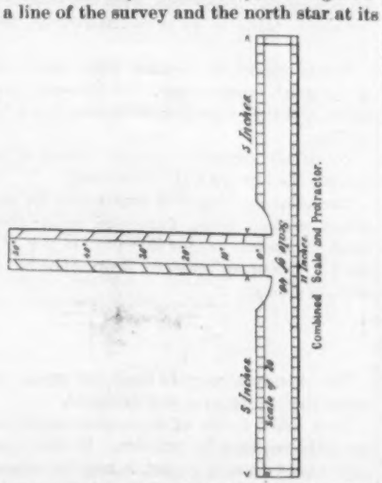
Let us suppose the instrument has been fairly adjusted in the morning on commencing work, and that it is required to produce forward a tangent given by two points. Set up the transit on the forward point, and, after sighting on the back

rod, set a point ahead on a large peg, then turn the instrument 180° and in the same way set another point, which may come on the same peg if the transit is nearly an adjustment. A tack driven in midway between the two points thus found will lie in the required tangent. This operation continued throughout the day will probably reveal the fact that the adjustment of the cross hairs is changing the whole time, demonstrating what has just been insisted on with respect to the level, that no instrument can be regarded as accurate, and that the most accurate running will be attained by those methods that balance these unavoidable errors of adjustment, graduation, etc. Thus, if the long tangent is on a preliminary line, it will probably be near enough to run alternately with first one end of the transit ahead and then the other. At every other transit point the lines of sight will thus be parallel, if the adjustment has not materially changed; so that if an even number of points have been placed, the instrument on the last line will be directed parallel to its first position. The line, however, is a series of zigzags. Where the same end is always kept ahead, it is evident that a curve in the same direction will be run. Thus, if the error of the transit is one minute or $\frac{1}{3438}$ in 100 feet, about, it is evident, by this ordinary method of running, that in 60 turning points the error of direction will amount to 1°; and yet, in spite of such plain reasoning, it is often difficult to get an assistant to adopt this plan of running alternately with different ends ahead on *curves* as well as *straight lines*, for the error is equally pronounced on both. To apply this rule, it is easy to remember that the object glass which just now pointed to the fore rod, at the next point must be directed, *without turning over the telescope*, to the back rod. With but one vernier, especially if it is not on the side, this method of alternating ends is a little more troublesome, but there can be but one judgment as to its utility. I have heard some engineers assert that it was impossible to run around the same curve twice, at different times, or with different instruments. If the errors of adjustment are not the same on the two occasions, this is true, if the same end of the compass box is always kept ahead, but it is not practically true when the method proposed is adopted.

In running curves, it is also advisable to keep the whole central angle on the arc, to avoid the repetition of errors in graduation about the zero point. In a similar manner, in running experimental lines, it is best to keep the *true* magnetic reading on the arc, all the time, in place of simply turning angles from zero. Thus, at the first station, set the vernier at 0, and then direct the transit north and south by the needle. Now, if the first line to be run reads N. 20° W. by the needle, on directing the telescope on this line, we see that the vernier will similarly show that 20° has been turned to the left from north. On moving the instrument to the next point, setting the vernier at 20°, if it has slipped, and sighting on the back rod, we have the transit again reading 20° on the first line. If the next deflection angle is say 30° to left, the vernier will now read N. 50° W.; similarly it will pass the 0 and 90° points, just as the needle (if parallel to its first position) does, and will agree with it throughout, so that by carrying out this method we always have the true magnetic course, to the first meridian, shown on the arc. The needle will thus tend to prevent large errors, as it will generally not differ over ¼ or ½ degree from the arc, except in iron districts. On connecting any two lines, having the same meridian to start with, the course on the plate, of the line common to both of them, should be the same. Using this method, combined with that of alternating ends, the error after a day's run should never exceed five minutes. My recollection is that an average error of two minutes is a fair allowance for a day's running in ordinary ground. This is not mere theory, for the writer has actually run several thousand miles of transit and levels, on most of which the methods detailed in this paper were used. In very rough ground the error will be very much greater, so that in *locating*, the direction must be constantly tested by turning into old lines.

It should be observed that in running long lines of 50 to 100 miles and over, that the variation of needle changes, so that the compass and arc will not agree throughout the line, especially if the direction is east and west; still the change will be very gradual. The same thing will happen from another cause—the attraction of the plumb line towards the center of the earth. Thus, if a transit line is started *due west* and produced around the globe (if that were possible), it would describe a great circle of the earth, cross the equator, go as far south of it as the initial point, and then return in a similar path to the beginning. Similarly start the transit line on any great circle of the earth and it will follow it.

It seems to me that a good way to meet this discrepancy between compass work (even when the variation of the needle is allowed for) and transit work, is to take, every ten miles say, the angle between a line of the survey and the north star at its greatest elongation, from which the azimuth of the line can be found and corrected. In plotting such a line, say 300 miles long, the meridians may be assumed parallel, as in Mercator's projection, and the line plotted from the correct azimuths found as above. If the line has to be plotted on any other projection, as the well-known polyconic projection, in use by the coast survey, so as to fit an existing map, then the meridians and parallels must be drawn first and the line plotted by the azimuths from the successive meridians.



Where a *map* of the entire line, or of several miles of it, is desired, it is best to put down a large paper protractor in the meridian and transfer by parallel lines any *course* (as given by the arc) to its proper place. The protractor is moved forward, when desired, along a straight line following the middle of the sheet. A *few* angles may be plotted, and, in fact, run in the field, as "deflection angles." The table of chords given in Trautwine is very accurate for this purpose, and is better for use than the very costly vernier protractors.

The adjoining figure is a skeleton outline of a combined scale, rule and protractor, that I have used for a number of years, and which permits of more rapid plotting than by any method I am acquainted with. The degree divisions, 10°, 20°, etc., are laid off along the stem from a table of tangents for a radius of 5 inches, the centers being at *c*, *c*; or better, a large protractor made by use of a table of chords can be used to graduate it. All the edges are beveled. The instrument is of German silver and cost $20, the great cost resulting from the difficulty of graduating the stem without a stamp made for the purpose. Its main defect is in not measuring angles over 50 odd degrees, though it is true that large angles do not occur frequently on railroad work; besides, they may be measured with this instrument in two operations.

Of the ordinary circular protractors, the best, to my mind, is a quadrant of 6 or 8 inches radius, divided to quarter of degrees *without* any vernier and moveable arm. Such an instrument has an advantage over the one above in that the degree divisions are uniform in length and can be more accurately laid off.

We must now draw these jottings to a close. An engineering acquaintance once spoke of our profession as "the profession of peg setters." This is eminently true of the field engineer, and the writer hopes that the desultory remarks above, suggested by his every day practice, may be of service to the young engineer in the more accurate "setting of pegs."

NOTES ON THE ACTION OF FURNACES, BOILERS AND STEAM ENGINES.

(*Concluded from page* 104.)

VIII.

EFFECTS OF DISTURBING CAUSES ON DIAGRAMS.

The theoretical diagram illustrated and discussed in Article V. will differ in several respects from the curve traced by the pencil of the indicator.

1. Wire-drawing at Cut-off.—The valve by which steam is admitted to the cylinder closes, in order to cut off the admission of steam, not instantaneously, but by degrees, especially when it is a slide valve. Consequently, the loss of pressure by the steam in passing from the valve chest into the cylinder gradually increases, and the pressure of the steam in the cylinder begins gradually to diminish, before the complete closing of the valve; so that the top of the diagram, which is drawn during the admission, instead of presenting a horizontal line, presents a drooping curve, convex upward, such as *AHG*. The point of actual closing *G* is usually marked by the point of contraflexure. The point of effective cut-off *B* may then be found by prolonging the expansion curve to meet the horizontal line *AB*, thus determining the effective ratio of expansion. A quick-closing valve will bring out the point *B* quite distinctly.

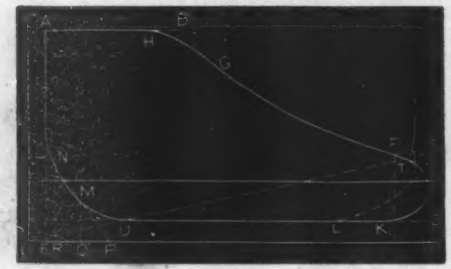
2. Release.—In order to diminish the mean back pressure, the exhaust port may be opened just before the forward stroke is finished. As the piston is then moving comparatively slowly, a little time is gained for the pressure to fall, and a saving of energy is insured. The curve *FIK* will be described if the exhaust valve opens at *F*; whereas, if it did not open until the piston arrived at *C*, we might get the curve *CL*.

3. Cushioning.—Closure of the exhaust valve at the point *U* on the return stroke will produce the compression curve *MN*. The elastic cushion of compressed vapor will assist in reducing the momentum of the moving parts, thus bringing the piston to rest more easily, and will diminish the effect of clearance, as stated in the last article.

4. Conduction of Heat.—Heat will be taken from the steam during the earlier part of the stroke by the walls of the cylinder, previously cooled by the exhaust. The steam will be lowered in temperature during expansion, and the cylinder will be taking up heat. Therefore, in the latter part of the forward stroke, the cylinder may be hotter than the steam, and will then return some of the heat to the steam, increasing its pressure. The expansion curve described by the indicator may thus at first lie below the theoretical

curve and then cross it and be above during the latter part of the stroke. If saturated steam is used, we shall have first condensation and then re-evaporation, affecting the expansion curve similarly.

If the indicator diagram has a compression curve, the amount of clearance, or the position of the origin O, may be thus obtained. OV is the vacuum line. Take two points, M and N, in the



compression curve; draw through them a straight line, NMP; make RO equal to QP; then will O be the end of the diagram, including clearance. Or by formula: if $MQ = p$, $NR = p'$, $QE = d$, $RE = d'$, and $EO = x$; the property of the curve gives

$$(x + d)\, p = (x + d')\, p', \text{ or } x = \frac{p\, d - p'\, d'}{p' - p}.$$

The geometrical construction will be seen to give the same value.

To find the true terminal pressure from the point of release F: Draw FS horizontally to the terminal ordinate through I, draw the straight line SO, and, from the point T, where it cuts the ordinate to F, draw TC horizontally. VC is the terminal pressure p.

IX.

EXPANSION CURVES.

There is a special curve, which represents the expansion of a gas when confined in a vessel possessing the imaginary property of not suffering any heat to pass through its substance, and where the gas is doing external work during its expansion. As the expanding gas does work, its temperature will fall by the conversion of the molecular motion of heat into the sensible motion of the mass upon which the work is done, and, since the pressure of a portion of gas is influenced by its temperature, the reduction of pressure will be greater than that exhibited by Mariotte's law. This curve of expansion is called an *adiabatic* curve, signifying "not to pass through;" that is that no heat passes from the gas by conduction or radiation.

To find the relations between the pressure, temperature and volume of a portion of gas when it is expanded or compressed, without addition or subtraction of heat: From the general equation, $p\, v = Rt$, where R is a certain constant, we obtain by differentiating,

$$p\, dv + v\, dp = R\, dt. \qquad (1)$$

Let k = specific heat of gas at constant pressure, and c = specific heat at constant volume. Then the quantity of heat necessary to be given to unity of weight of gas, without change of pressure, in order to increase the volume by dv, is $k \frac{dt}{dv} dv$, and the quantity of heat required to increase the pressure of the same portion by dp, without change of volume, is $c \frac{dt}{dp} dp$. If the variations of volume and pressure occur together, the whole quantity of heat required will be $k \frac{dt}{dv} dv + c \frac{dt}{dp} dp$.

If the equation $p\, v = R\, t$ is differentiated, first on the supposition that p is constant, and second that v is constant, we have

$$\frac{dt}{dv} = \frac{p}{R} = \frac{t}{v}; \quad \frac{dt}{dp} = \frac{v}{R} = \frac{t}{p};$$

therefore the quantity of heat is

$$\frac{kt}{v} dv \times \frac{ct}{p} dp = o$$

by hypothesis, since there is no addition or subtraction of heat. Cancel t and substitute in (1), obtaining

$$p\, dv - \frac{k\, p}{c} dv = R\, dt = \frac{p\, v}{t} dt, \text{ or}$$

$$-dv \left(\frac{k - c}{c}\right) = \frac{v\, dt}{t}, \text{ or if } \frac{k}{c} = n,$$

$$-(n-1)\frac{dv}{v} = \frac{dt}{t}.$$

Integrate between limits v and v_0, t and t_0,

$$log. \left(\frac{v_0}{v}\right)^{n-1} = log. \frac{t}{t_0}, \text{ or}$$

$$\left(\frac{v_0}{v}\right)^{n-1} = \frac{t}{t_0} = \frac{p\, v}{p_0\, v_0}, \text{ whence}$$

$$\frac{p}{p_0} = \left(\frac{v_0}{v}\right)^n \text{ or } p\, v^n = \text{constant},$$

which is the equation of the adiabatic curve.

We may have several expansion curves, according to the conditions under which expansion takes place. The curve of expansion of a perfect gas under *constant temperature* is, as before stated, an equilateral hyperbola, with the equation pv = constant. This is an isothermal curve, and here $n = 1$.

When steam in contact with water expands at constant temperature, the *pressures* are constant, and the expansion curve becomes a horizontal line.

When air expands without accessory heat it follows the law $pv^{1.41}$ = constant.

The adiabatic curve of expansion for saturated steam, no heat being furnished to or abstracted from the steam, has for its equation $p\, v^{\frac{10}{9}} =$ constant. The mean pressure, deduced as in Art. V., will then be $p_m =$

$$p_0 \cdot \left(\frac{10}{r} - r^{\frac{9}{10}}\right)$$

This formula may be used for mean pressure when the cylinder is not jacketed.

Two other forms of expansion curve may be partially realized in practice. If the steam receives heat from a jacket, it may be supposed, in one case, that just enough heat is imparted to the steam to prevent condensation when the steam is originally *dry* and *saturated*, or just enough to preserve the quantity of vapor constant, if the steam is mixed with water at the beginning of the expansion. This curve will lie above the adiabatic. Another case is that in which the *interior work* of the vapor and water remain constant—that is, there is neither evaporation nor condensation, and the *temperature* remains constant. This curve lies above both the preceding.

In estimating theoretically the power of an engine with a steam jacket, it is not known what quantity of heat is furnished by the jacket, nor what relative quantities of vapor and water will be found in the cylinder at the beginning of expansion. It is usually assumed that enough heat enters the cylinder from the jacket to prevent the condensation which would occur if no heat were added; that the expansion curve is that of quantity of vapor constant; and that the steam is saturated and dry at beginning of expansion. Then

$$pv^{\frac{17}{16}} = \text{constant, and } p_m = p_0 \left(\frac{17}{r} - r^{\frac{16}{17}}\right)$$

The adiabatic curve for superheated steam has the equation $pv^{\frac{1}{3}} =$ constant. The curve for interior work constant (temperature and state of aggregation), is an equilateral hyperbola.

The following table, which may be useful for plotting the curves, shows the lengths of ordinates for expansion curves, expressed in percentages of the lengths of the first ordinate or initial pressure:

No. of Ordinate.	$p \propto r^{-\frac{10}{9}}$	$p \propto r^{-\frac{17}{16}}$
1.5	63.73	65.02
2	56.87	47.87
2.5	36.10	37.78
3	29.49	31.12
4	21.41	22.92
5	16.72	18.09
6	13.66	14.90
7	11.51	12.65
8	9.96	10.98
9	8.70	9.68
10	7.76	8.66
11	6.96	7.88
12	6.33	7.14

The use of the steam jacket is economical of heat, not because condensation during expansion by the adiabatic curve is in itself a loss of heat, but because the presence of liquid water in the form of cloud, or in any other form in the cylinder, renders more rapid the interchanges of heat between the metal of the cylinder and the hot entering steam from the boiler, lowering the initial pressure and increasing the final pressure in a way that cannot be estimated theoretically.

CORRESPONDENCE.

ERRORS IN TRAUTWINE'S RAILROAD CURVES.

Editor Engineering News:

I will call your attention to a misprint in Trautwine's Railroad Curves. In table of radii, page 33, edition of 1880, it is printed radius 1° curve = 5,830—correct, 5,730.

Very truly yours, Wm. W. Kenly,
Resident Engineer B. & O. R. R., Grafton, W. Va.

PROBLEM FOR ENGINEERING STUDENTS.

Saucon, March 28, 1881.

Editor Engineering News:

On July 1, 1880, a certain company appointed a coal agent, agreeing to furnish him with capital and pay him a salary of $350 for six months, all the coal on hand at the expiration of that time and all the profits of the business to be turned over to the company. The company furnished him with coal to the amount of $825.60 and in cash $215. The agent received for coal sold $1,323.40, paid for coal bought $937, paid to the company, $300, paid one-half of his own salary, $125, paid sundry expenses authorized by the company, $29, and delivered to indigent persons by order of the company coal to the amount of $13.50. On Jan. 1, 1881, the company took possession and found coal on hand to the amount of $616.50.

(1) Had the agent any money in his hands on Jan. 1 belonging to the company? (2) And if so, how much? (3) Or did the company owe the agent? (4) And if so, how much? (5) Did the company gain or lose by the transaction? (6) And how much? Yours, K. M. Puter.

[We insert the above problem, but will not publish the *method of solution*. The most we can allow space for is "Yes" and "No," and "Amounts," in answer to the queries in last paragraph. Answers will be received for two weeks only.—Editor Engineering News.]

FIELD BOOKS AND LOGARITHMS.

NO. 2.

Iowa City, Iowa, March 23, 1881.

In the "News" of March 19, Mr. Wm. H. Searles brings forward an elaborate logarithmic solution of Mr. L. E. Vel's problem, and challenges me to produce one by the "Natural Method," or by the aid of any "useful" tables, "equally accurate," if "equally brief."

I am happy to respond to both alternatives of the challenge, and with a very wide margin to spare.

In the figure let AP be the 2° curve, radius R_1

and PB the 1° curve, C and O their centers, etc. Prolong AP to K, CK being parallel to OB, and draw the tangent DKH.

Now $BH = BO - CK - OL = R_1 (1 - \cos. 20°)$

and $CD = \frac{BH}{\cos. 30°} = R_1 \left(\frac{1 - \cos. 20°}{\cos. 30°} \right)$.

Also $AD = R_1 \tan. 30°$

$$AC = R_1 \left(\frac{1 - \cos. 20° + \sin. 30°}{\cos. 30°} \right) = R_1 \left(\frac{1\frac{1}{2} - \cos. 20°}{\cos. 30°} \right) =$$

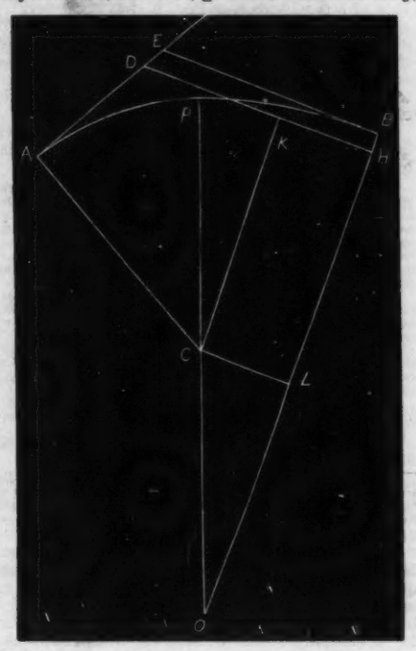
$(2864.93 \times .56031) + 80603 = 1859.552 +$

That my solution is brief, indeed, contrasted with Mr. Searles' is evident at a glance.

No fault need be found with either on the score of accuracy.

I have only five-place tables just at hand, and Mr. S. takes logarithms to six places, which would account for a slight difference in results.

My formula, however, gives the results *directly*,



and therefore those results are just as perfect as the data upon which they rest.

This is not the case with Mr. S.'s, for he requires five formulæ to effect his solution, and is obliged to express an auxiliary angle, which so far as the seconds are concerned can be done only approximately.

I did not agree, however, to point out "any inaccuracy" in this particular solution of his. Since he has challenged me to point out "any inaccuracy," however, it is, I hope, not ungracious in me to instance the above inherent in his method and affecting his result.

Let us look a little further:

Mr. S. takes out, if I count correctly, five different logarithms, and finds three numbers from their logarithms.

But again, some nineteen operations of addition, subtraction, multiplication and division are required in taking out the above logarithms and finding the corresponding numbers.

The additions and subtractions that appear in the published solution I will not stop to mention.

Since my solution requires only three simple operations, that any one can perform, and upon one equation, I now see (?) how the solution of Mr. S. offers "such an excellent refutation of the astonishing statements made by Professor Philbrick."

Who would be most likely to find it necessary to retire to the "kindly shade of a neighboring tree," squandering meanwhile the "wages of six or eight men"—Mr. S., with his score or two of computations that he must perform, aside from and simply incidental to his logarithmic elaborations proper, or myself, with but three such operations in all, and no logarithmic entanglement whatever?

Mr. S. is unfair in intimating that "all the figures required" in my solution should be published "in full," while from *his* solution are *omitted* many more than all that are required in mine.

I must correct a few misstatements of Mr. S. He says "the professor plainly takes the ground that logarithms are worthless."

I did not; but I challenge any one to show that within the whole range of mathematics they have any uses not admitted in my article.

I did not state that "logarithmic tables are less accurate than tables of natural numbers;" I made no comparison between the two.

I did not state that "approximate formulæ yield more accurate results than accurate formulæ, if the latter are at all tainted with logarithms."

I did state that "some simple, approximate, trigonometric formulæ yield results more accurate," etc.

But it is much easier, "simply and explicitly," to deny, than to disprove my statements. If Mr. S. could produce but one case in which I have made the slightest mistake it would be much more relevant to the case in hand than all his "explicit denials," false statements and unworthy insinuations.

Evidently Mr. S. is a stranger to "short and simple methods."

He is beyond all question an able mathematician and engineer—but his mathematics is almost hopelessly incumbered with logarithms.

Perhaps he might learn of some professor, "even a professor of civil engineering in a State university," short and simple methods, which would enable him to reduce his volume of 500 pages to the convenient size of 100 or 200 pages at most.

P. H. PHILBRICK,
Prof. Civil Engineering, etc.

RAILROAD GRADES.

TOPEKA, Kan., March 22, 1881.

EDITOR ENGINEERING NEWS:

In reply to C. W. Brown as to grades, I will say that a maximum grade is one adopted by the engineer at the outset as the most economical one. Nothing but economy, first and last, fixes grade. If, then, it is economy to use the maximum, what reason is there, except in extreme cases, for a *neglect* to use it? H. V. HINCKLEY.

THE INACCURACY OF THE U. S. PUBLIC LAND SURVEYS.

OMAHA, Neb., March 23, 1881.

EDITOR ENGINEERING NEWS:

There is a subject of much importance to the profession which seems to have been thus far wholly ignored in your journal; one whose magnitude both in the relations it bears upon the future of the West and the vast expenditures of money it involves certainly deserves some consideration. I refer to the U. S. public land surveys. A characteristic feature of ENGINEERING NEWS in the past few years has been the chronicling of organizations of State surveyor associations. These bodies have met to devise some system of correcting notoriously bad surveys of the U. S. government and establishing some reliable basis for future work. They have gone so far in their efforts at reform as to seek to establish some laws regulating the practice of surveys in their respective States.

In view of these facts is it not about time, by the light of past experience, to seek the prevention of a recurrence of such reckless work in the existing territories where surveys are being conducted? Why waste millions of dollars in inaccurate work now and embarass future generations with treble expenditures to correct the errors. It will be asked: Are millions of dollars being wasted? Is not the present system a good one and are not its supervisors competent and honest men? To these questions I most emphatically answer No! In Nebraska, Wyoming, Dakota, New Mexico, and I venture to say nearly every territorry where land surveys have been conducted under public disbursements through the U. S. surveyor general departments, these surveys have been awarded to political satellites of congressmen, senators, and local politicians; the work has been done in shameless disregard of specifications, and without any view to future utility. These are broad and general charges—can they be verified? Let us see. I have lived in Nebraska over 17 years. During my residence, I have pursued the vocation of engineer and surveyor almost uninterruptedly. I have had opportunities to test surveys and have come in contact with men who have conducted them. With but few exceptions the sectional surveys are not only notoriously inaccurate, but in portions of the State have been nominally made, money drawn for the work and scarcely a vestige left in the shape of corners to retrace a line. Our settlers instead of finding well defined corners whereby to make homestead selections have in countless instances been forced to club together to employ private surveyors to locate their farms. How can this be? Does not the government appoint inspectors to test all surveys before settling with them and are not the contracts let to surveyors? Yes; inspectors who do not understand the first principles of surveying are sent for the sake of formality and in the interest of the contractor. As to the contracts they are let to political satraps, nine-tenths of whom know nothing about the business. I need but name one instance to illustrate the fitness of these surveyors. Some years ago, when occupying the position of City Engineer of Omaha, I was called upon by a gentleman who wanted instruction in the use and management of a transit; he offered to work a week for me free in exchange for such instruction. That man was placed in charge of the Colorado and Wyoming boundary survey. Why? Simply because he had political influence. But let us go to the real root of this terrible evil. We have these public surveys intrusted to officers in each district entitled surveyors general. One would think that such an official should unquestionably be a surveyor—certainly with the same degree of consistency that an attorney general should be an attorney. But is it so? Let us see. Nebraska has had surveyors general in charge of public lands now for over 20 years. In all that time not an instance can be cited where a surveyor has been appointed, but on the contrary the office and its patronage has been treated as a plunder pot. In the time specified over a million dollars has been expended in sectional surveys alone. The question will be asked: Are the contracts not let to public bidders, or are not men selected of reputed professional ability? No; contracts are let at appropriation rates to men who are either in collusion with the surveyor general or ex-members of legislature who have voted for senators, or some other political ward politicians. The present surveyor general of Nebraska, Mr. Smith, is a lawyer who makes no pretence to any knowledge of surveying. Ditto with Surveyor General Atkinson, of New Mexico. In relation to the letting of contracts I talked some years ago with Mr. W. P. Dewey, ex-Surveyor General of Dakota, on the subject. He too was a lawyer with no knowledge of surveying. He informed me that he was constantly hampered in the letting of contracts for surveys by letters from congressmen in the interest of friends. And he informed me that in some instances requests of that character came even in the interest of congressmen themselves, and he had to yield. Now what kind of public service is this? What a mockery to call together the surveyors gen-

eral of the country as was heralded last fall in the press, for the purpose of devising improvements in the surveying system! Would you expect to convene blacksmiths to devise methods of improving chronometers, or carpenters to decide upon the merits of steam engines? Look at the instructions published a year ago and see whether they in themselves are not self-condemnatory. A standard chain is made 66 $\frac{0}{100}$ feet. Why? To make up errors in measurement. The use of stadia, aside from giving approximate elevations, could certainly come much within such a margin. The occasion of this wide margin is accounted for simply and solely by the fact that notoriously reckless contracts are let, and unreliable surveys are made. With incompetent men in charge, with a rotten system of contract in vogue, and dishonest and incapable inspectors, is it to be wondered that States are compelled to do all the work over again, our settlers put to an eternal annoyance over boundary inaccuracies, and the courts kept busy over endless litigations? I have thus thrown out a few hints and hope that the surveyors throughout the West will take the matter in hand and adopt some method to remedy the evils.

ANDREW ROSEWATER.

ENGINEERS' SOCIETIES.

CIVIL ENGINEERS' CLUB OF PHILADELPHIA.

MARCH 19, 1881.

Vice-President Henry G. Morris called Prof. L. M. Haupt to the Chair.

A paper was read by Col. Wm. Ludlow, inviting attention to the practical neglect, in this country, of military engineering, the power of heavy ordnance, and a formula given for calculating the penetration into solid iron of a projectile with a certain diameter and striking velocity. Three classes of modern naval vessels were referred to; the mailed war ships with armor 2 or 3 feet in thickness, the iron or steel cruisers, and those of the "composite" type with metal frames and wood planking. The English system of coast defence, of iron or steel plates 6½ in. thick, alternating with layers of teak, was briefly described as well as the Grasen system of chilled cast iron or steel, in heavy masses of curved section.

The ultimate connection between the ship building and iron industries of the country, and the universal employment of metal in the preparation of war material were pointed out, and the plea advanced that the construction of a naval force and of adequate defence for important harbors was clealy demanded, not only for the protection of national, interests at home and abroad, but also as the most effective means of stimulating our moribund ship building arts into life and advancing the metal producing and cognate industrial interests of the country.

Prof. L. M. Haupt read a paper descriptive of the deflecting armor designed by Mr. N. B. Clark, Past Asst. Engr. U. S. N., for sea-coast defense. The inventor's improvements are based upon the fact that it is much simpler to resist the effect of a projectile by deflecting it, than by opposing it by thick masses of inert matter, as is evinced by the "ricocherting" of a shot upon the water. He protects all the vital parts of the vessel by an iron shield, convex upward, placed below the water line, and so curved that a shot cannot strike point blank. The guns are mounted upon the back of this shield, but encased in double convex discs, which are practically invulnerable. They are worked by very ingenious but simple devices in the hold, and loaded, swabbed and run into position for firing by hydraulic pressure. It is claimed that by this means a great economy is effected in the weight of metal required for attack and defence, the vessel is more readily handled, more seaworthy and is invulnerable. The principle may be applied equally well to the construction of batteries for defence on shore.

Mr. H. A. Vezin presented a most interesting description of his recent investigations of the coal and iron mines and the railroads and harbors of southern Russia, illustrated by maps of the territory and specimens, and enlivened by many amusing and instructive anecdotes of engineering schemes and methods in that country. The coal basin, where his examinations were made, is about 160 miles E. and W. by 60 miles N. and S., the coal varying in quality from very hard anthracite in the east, to very inferior gas coal, in the west. The iron of the coal basin is a brown hematite, formed by the decomposition of the carbonate of iron, and poor in quality, but red hematite occurs further east and accessible from the coal mines.

The relations of the government to the railroads, and of the latter to the producers and shippers; the rude, and, notwithstanding the great cheapness of labor, the very expensive method of transporting and shipping the coal; the extraordinary transportation of timber to that almost treeless region, and the difficulty of loading or discharging vessels in the shallow harbors, together with many other matters of information and interest connected with the iron and coal industries, were very interestingly treated. The remainder of the evening was spent in discussion of these subjects.

HOWARD MURPHY, Corresponding Secretary.

THE MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS.

The second meeting of this association was held at Lansing, Michigan, on January 11–13, 1881; the following is the roll of members, with the post office address:

Arnold, A. R., Mt. Pleasant; Bullock, M. W., Howell; Bailey, M. H., Dimondale; Beden, S. N., Pine Run; Bannister, A. M., Jackson; Bartholomew, H. D., Lansing; *Blair James, Adrian; Brown, P. M., Smith's Creek; Brown, Geo. M., East Saginaw; Bonnell, B. C., Pioneer; Brown, Thomas J., Mason; Bradt, J. C., Marcellus; *Baker, Chas. L., Ann Arbor; Begle, Chas. A., East Saginaw; Carpenter, Prof. R. C., Lansing; *Cook, Percy T., Brooklyn; *Cooley, Sloan, Four Towns; Caukin, H. M., Greenville; Cummings, Geo. P., Marquette; *Cobb, L. S., Winfield; Cary, Harrison, Saginaw City; *Cornell, Thomas, Ionia; Heald, P. C., Midland; Huggins, Andrew, Corunna; *Hamilton, Chas., Bronson; Holmes, Chas., East Saginaw; Hodgman, S. C., Traverse City; Holden, D. F., Ovisitt; Hastings, S. S., St. Louis; Herbert, F. H., East Saginaw; Jipson, W. C., Blissfield; Johnson, J. M., Bay City; *Jennison, H. H., Eagle; Kent, Burton, Adrian; *Kinnefick, J. S., Capac; Leavenworth, I. H., Sag. City; Love, Thomas, Avery; Lawton, C. D., Lawton; *Lovewell, N., Coldwater; Lawson, J. S., Disco; Mason, Lyman, Owosso; *Masson, George, Detroit; *Martin, E. C., Evart; *Mitchell, John A., Ludington; Collar, H. A., Grand Rapids; *Cook, M. S., Manistee; Davis, Prof. J. B., Ann Arbor; Drew, A. L., Three Oaks; Donavan, Wm., Lansing; Dixon, J. R., Boyne Falls; *Drake, A. P., Mason; Dunbar, E. L., Bay City; Eaton, Albert, Otsego; *Fosdick, A. A., Gaylord; Foster, R. J., Coopersville; Fessenden, C., Romeo; Guild, E. F., East Saginaw; Gardner, Albro, Allegan; Greene, Prof. C. E., Ann Arbor; *Gillette, L. S., Niles; Greiner, R. C., Grand Rapids; *Goodell, E. J., Ecorse; *Glaser, Chas. A., West Bay City; Hollister, C. E., Laingsburg; Mark, Geo. A., Hillsdale; McElroy, Michael, East Tawas; *Niles, I. P., Coopersville; Olmstead, H. F., Midland; Palmer, Jno. O., St. Johns; Pearsons, H. C., Ferrysburg; Pierce, A. J., South Haven; *Palmer, A. H., River Raisin; *Palmer, F. A., McBride's; Pettibone, D. A., Bridgeport; Reed, A. L., Port Huron; Rothwell, H. G., East Saginaw; Skeels, D., Grand Rapids; Stage, M. B., Clio; Smith, E. C., Pontiac; Snover, C. M. C., Jackson; Steele, Geo. E., Elk Rapids; *Sinclair, A., Port Huron; Smith, Amos, Vandalia; Sanborn, J. M., Pine Run; Hodgman, F., Climax; Hyde, Chas. B., Jackson; Sherman, J. E., Lansing; *Smith, Richard, Port Austin; Sanderson, Jas., Detroit; Sears, Wm. B., East Saginaw; *Thompson, H. C. W., Bay City; Teed, A. J., Cadillac; Terry, H. E., Pontiac; *Teller, Isaac, Cohoctah; *Todd, O. H., Colon; *Thornton, Wm., Grand Rapids; Treadwell, E., East Saginaw; Vincent, Wm., Manistee; *Vanzalingen, H. B. W., Musk'n; Smith, J. N., Bath; *Strudwick, Henry, Bad Axe; Van Liew, E. S., West Bay City; White, Thomas, Alpena; Watkins, John J., Lapeer; *Whallon, J. M., Fitchburg; Welles, B. F., Marshall; *Woodard, C. S., Ypsilanti; *Wilmarth, A. H., Sand Hill; Yokum, J. K., Waterloo.

HONORARY MEMBERS.

John F. Munro, Detroit; W. L. Coffinberry, Grand Rapids.

The attendance was good, varying from thirty-six at the opening to nearly one hundred, with a corresponding interest and evident determination to accomplish the declared objects of the society. In regard to the manual, the committee placed in charge of that work reported that they had not yet actively entered upon its construction, and they submitted their general plan to the society, and would be governed by its action. The points submitted were: That the mathematics of surveying should be excluded so far as already supplied by text-books. That it should deal with the principles involved in the practice of the profession, and define and clearly illustrate their practical application. That it should contain the laws of Congress and the instructions to United States deputy surveyors from the beginning. Then, all available decisions of United States and State courts arranged so as to confirm the truth of certain pertinent propositions—for instance: Proposition I. Corners fixed by the United States survey can not be removed. Proposition II. Monuments are to govern in preference to courses, distances, maps, or computed areas. The application and force of these several propositions to be illustrated by the presentment in connection of cases of actual occurrence. That it should treat the magnetic variation of the needle in the endeavor to secure its common understanding and use. Finally, that while the work is by the surveyors of Michigan, and undertaken to serve their need, yet it is believed that it may prove of great value in all the public land states.

*Under the standing resolution as to absent members.

The following questions of practice were submitted, with the results appended:

Case 1. In 1838 the center of sec. 21 was established by bisecting the e. and w. ¼ line. About the same time a road was laid on the n. and s. ¼ line and irregularly fenced, so that the parties never joined fences along this line.

In 1858 the center of the section was again determined in the same manner—but changed. About this time, ¼ post on n. side was dug out and lost. In 1866 the center of the section was again set in the same way, and again moved.

In 1871 the lost ¼ post on n. side was put in equidistant and on right line between n. e. and n. w. corners. In 1877 the center was determined by the intersection of right lines joining opposite ¼ posts, and so established, making the fourth center. Query: Which is the legal center? Ample discussion followed, and though no vote was had, the expression was chiefly in favor of the last center set.

Case 2. Orally presented by Mr. Skeels, and was that of a subdivision of Sec. 6, having several peculiar features. The society gave its attention chiefly to the subdivision of the three fractional quarters of the section, after the quarter lines are run; the question then being: "Shall each of these quarters be treated by itself and independent of all beyond its own boundaries."

Pending which Mr. Pearsons read the following letter from the commissioner of the general land office, bearing date Sept. 2, 1876:

SIR: I am in receipt of your letter of 21st ult., concerning subdivision of fractional quarter-sections. In reply, I have to say that, upon the lines closing on the north and west boundaries of a township, the quarter-section corners are established by the U. S. dep. surveyors at precisely 40 chs. to the N. or W. of the last interior section corner, and the excess or deficiency in the measurement is thrown on the outer tier of lots as per act of Congress approved May 10, 1800.

In the subdivision of quarter-sections, the quarter-quarter corners are to be placed at points equidistant on straight lines between the section and quarter-section corners, and between the quarter-section corners and the common center of the section—except on the last half-mile of the lines closing on the N. and W. boundary of a township, where they should be placed at 20 chains original measurement to the N. or W. of the quarter-section corners.

Yours respectfully,

J. A. WILLIAMSON, Commissioner.

The following resolution was then introduced and passed, with one dissenting vote:

Resolved, That in subdividing sections, sub-quarter lines shall only be run across the quarter-section they divide; and their termini shall be points on the section or quarter-section lines at distances between the corners which determine them, proportional to the original measurements.

The application of this resolution to the case in hand would produce an angle in the west sub-quarter line at its intersection with the east and west quarter line. Mr. Skeels, dissenting, said he hoped the resolution would not be adopted, believing it contrary to the U. S. laws, and in support of his position quoted from the manual by J. H. Hawes, 1868, as follows, pages 135–136:

It must be borne in mind that the boundaries of the public lands established by the government surveyors are unchangeable. * * *

The following will enable the surveyor to divide the section into its legal subdivisions in conformity with the laws of Congress:

No. 1. * * * It will be useless, therefore, when called upon to subdivide a section where one of the original corners was established out of line or out of measurement, to attempt to make such a division as will give an equal area to even two of the subdivisions. It cannot be done without violating the rules prescribed by Congress in such cases.

No. 2. (Refers to the re-establishing of corners.)

No. 3. The quarter-quarter corners not established by deputy surveyors *must be planted equidistant and on line between the quarter post and the section corner.*

No. 4. All the subdivisional lines of a section *must be straight lines, running from the proper corner in one exterior line to its corresponding corner in the opposite boundary of the section. There is no exception to this rule.*

Also, on page 142 of the same manual, from the letter of June 11, 1864, by Commissioner Edmunds, the following:

All lines subdividing a section must be *straight lines* running *through* the section, from the corner in one boundary to its corresponding corner in the opposite boundary of said section.

Case 3. By Mr. Caukin: Corner to sections 4 and 5 on n. boundary, which is a correction parallel, is lost. U. S. field notes give no distance to any other corner on the boundary. I ran a straight line from corner to 4, 5, 8, and 9 through ¼ post to 4 and 5, to the boundary, and established the corner at my intersection. Was that correct? Vote unanimous in the affirmative.

Case 4. By Mr. Pettibone: As to the method of locating the n. w. and s. w. corners to section 7. In the case of the n. w. corner the principle would appear to be the same as in No. 3, by Mr. Caukin. Owing to an impassable marsh no corner to 6 and 7 on w. boundary was set by U. S. survey, but on the eastern portion the line was sufficiently marked by blazed trees so that it could be projected westward to the boundary. As to the s. w. corner, the U. S. field notes show it to have been duly set at

an intersection, 5.90 chains north of the corner to 12 and 13, but no evidence of it is to be found on the ground. The eastern portion of the line between 7 and 18 is amply marked by blazed trees, but when projected westward makes an intersection only 1.30 chains north of corner to 12 and 13, instead of the 5.90.

Both questions were voted upon together, 14 to 9 in favor of projecting the lines westward to an intersection, and there establishing the corners.

Case 5. By Mr. Mark: Similiar to No. 3, by Mr. Caukin, except that there was no monument by which the line could be projected. Answered to the effect that the line should be projected on an intermediate course between the lines east and west of the one in question, and corner established on the boundary accordingly.

Many other questions of practice were submitted orally and discussed, with how much of profit those present will judge. In this connection the reader is referred to the standing resolution as to executive committee, and their remarks thereunder.

Mr. Hodgman exhibited a home-made beam compass—a rod of wood three-sixteenths of an inch square of any length, with a large needle at one end for the fixed point, and a large cork fitted to slide snugly along the rod and to carry an ordinary ruling pen. Mr. Bailey explained his method of attaching a small telescope to his compass, thus making a substitute for a high-priced transit. Mr. Steele exhibited a steel tape, manufactured by Mr. Hodgman of Traverse City. Discussion of chain *vs.* tape as a measuring instrument ensued, and resulted in the adoption of the following:

Resolved, That this association recommend the use of the steel tape as a more accurate instrument of measure than the chain.

Mr. Mark, of Hillsdale, asked the advice of the society as to the proper method of re-establishing the corners marking the boundary of the State line between Michigan and Ohio, and a resolution was adopted recommending the Legislature to appoint a commission of competent surveyors, to act in concert with a like commission from the State of Ohio, "to examine into and report on the condition of the boundary in question, to the end that it may be preserved and suitably perpetuated."

Early in the session of the society Messrs. Pearsons, Guild, Fessenden, Skeels, and Bartholomew were appointed to consider and report upon desired legislation. Later, to give the "county surveyor" fair representation, Messrs. Drew and F. Hodgman were added, making, with Mr. Skeels, three county surveyors on the committee. The committee reported a measure to amend act 159 of 1877 so as to make the surveys contemplated thereby, a charge upon the lands concerned, and to repeal act 205 of 1879, which fixes the expense of such surveys on the county at large.

The committee also reported a measure to provide for organizing the surveying service of the State; to secure a uniformity of practice, use of standard measure, and for the more complete recording of surveys of a permanent nature.

These measures were carefully gone through with by the society in discussion, variously amended, and re-referred to the committee to be presented to the Legislature. At the close of the meeting Mr. Skeels was replaced on the committee by Mr. Teed, on account of the former's necessary absence.

At the last session the society passed a resolution instructing the secretary to ascertain the price of the vitrified corner stake manufactured by the Jackson Fire-clay Company, and the prices in quantities of twenty and one hundred. Several specimens were shown, and it was informally agreed by several leading members that a simple cylinder three by twelve to forty inches would be the most practical form, each stake to have a center indicated by grooves crossed at right angles. In reply to inquiries by the secretary, the company replied that they manufactured a vitrified stone stake "from ground stone, soft shale, with a portion of fire-clay and the celebrated Portage potters' clay ground fine, rendering it homogeneous and uniform throughout; pressed through dies by powerful machinery, and after being subjected to a heat so intense that no iron or common clay will stand—in kilns constructed of fire brick—it makes a thoroughly vitrified stone corner stake that is warranted to be impervious to the action of frost, chemicals, or acids, and of same material as our vitrified stone sewer pipe which has for many yeas stood the test under the most unfavorable conditions."

The stakes are three inches in diameter, from one to three feet in length, with a cross (+) on one end. They are also made with a head and place for fastening metallic figures to indicate township, section, etc. In regard to cost the company said: "We will furnish these stakes without heads at ten cents per lineal foot, cut in lengths of one, two, or three feet, free on cars here; and if purchased in quantities sufficient to supply a whole county at once, would make a special discount of ten per cent."

In this connection the following, by Mr. H. C. Pearsons, on the value of wood as compared with stone for monuments or landmarks, is given:

"Wood, though much used for the perpetuation of landmarks, has been looked upon as a frail and short-lived material, as a kind of compromise between necessity and utility. But from the results of some recent retracement of old lines, I am able to vindicate the merit of wood.

"Through the kindness of Capt. H. W. Clarke, of Syracuse, N. Y., who was surveyor in charge of the retracement of the boundary between the States of Pennsylvania and New York, I am in receipt of his report of two seasons' work, embracing the retracement of some 210 miles of the boundary supposed to be on the parallel of 42° n., together with some 19 miles of the meridian boundary on the west side of the State of New York.

"On the eastern portion of this parallel, Mr. Clarke retraced 119 miles in the year 1877. In this distance, including the initial monument, latitude, and intermediate milestones, 132 monuments of stone were known to have been set during the original survey in 1788 and 1787. Of these he found only 55 evidently in place, thus showing a loss of over 58 per cent. in about 91 years.

"On the western part of the boundary, in 1878, the fatality of land marks was even greater, it being about 65 per cent. Of the monuments out of place, a number were found and recognized by the marks on them, while others were totally lost—fire and the plow being their chief enemy.

"On the meridian boundary, on the west of New York, Mr. Clarke found some 19 miles of line marked orginally by 20 monuments—14 of stone and 6 of wood. Of these, *two stones* were found *in place*, and one stone was out of place and place lost, while eight stones with their places were lost, and one of the stones in place was broken.

"Of the six posts originally set, two were found in place, though rotted off at the ground and fallen over, their places being identified by their 'rotten remains' in the ground. One of these posts was a chestnut, about six inches square; manner of setting not specified. The other was a cherry, set in pile of small stones; size of post not specified. One post was replaced a few years ago with a stone, and three others with their places were totally lost.

"In this history, the wooden monument, it is seen, has established for itself a creditable record; so that henceforth, in localities where others are impracticable, we need not be afraid to look with favor on a good post, *set deep* in the ground, and surrounded with *stones, lime, broken brick* or other matter foreign to that in which the pit for the post is made."

Papers were read by Judge Cooley, Prof. C. E. Greene and Messrs. H. D. Bartholomew and F. Hodgman, and were but briefly discussed. We will publish the papers in future issues.

MEXICAN NEWS.

The Mexican Chief Engineer has surveyed the Tehuantepec route and reports Captain Eads' project to be entirely practicable.

PHILADELPHIA, March 29.—The Mexican Central Railway and the Mexican National, or Palmer & Sullivan, as it is better known, have for some months been negotiating with large firms here for railway supplies of all kinds. The Mexican Central has already received six locomotives from the Baldwin Locomotive Works, and thirty more are now building for it by the same firm, and additional orders are expected. The largest order which is under way is from the Palmer-Sullivan road. Some months ago the Baldwin Locomotive Works sent in bids to supply this road with 200 locomotives. Their specifications were approved, and they shipped for trial four locomotives. This was four weeks ago. The firm has now been notified that it is to receive the contract for the 200, and it has already begun to build them. They are to be shipped as wanted, all to be finished by January 1, 1883. The value of the contract is said to be $1,500,000. The engines are to be the strongest ever built by the works, which have turned out the strongest known. Half the order is for passenger engines and the remainder for freight and general use.

The contract for the building of a railroad between Guaira and Caracas (Venz.) has been signed between Mr. Pile and the government.

NOTES.

HYDRAULIC CONCRETE FOR CULVERTS.

One measure of Rosedale (or any equivalent cement); 1 measure of slaked lime in powder; 4 to 4½ measures of clean, sharp sand; 9 to 10 measures of pebbles, small fragments of stone or brick, oyster shells or a mixture of them all. When Portland cement of standard quality is used the proportions may be: One barrel of Portland cement as packed for market; 1 barrel of common lime, producing 2¼ to 2½ barrels slaked lime powder; 9 to 10 barrels of sand; 15 to 17 barrels of the coarse materials.—*Gillmore's Roads, Streets and Pavements.*

THE USE OF STEEL.

Dr. Siemens claims that whenever strength and magnitude are both required, the use of steel is without a rival. He asserts that even for an ordinary house steel gives more security than wood, is six to eight times as strong, and costs less. He thinks that ere the lapse of many years steel will be introduced into buildings of all kinds, and that it will gradually supplant iron, in the same way that iron already tends to take the place of wood.

TELEPHONY WITHOUT MAGNETISM.

An important step, says the *Nature*, has been obtained in telephony by Dr. Cornelius Herz. The principle of magnetism has been entirely discarded, and the magnetic receiver abolished. A long series of experiments have been successfully conducted under the patronage of the French Government on the telegraphic lines of the State; concluding trials were witnessed, among others, by M. Cochéry, Ministry of Postal Telegraphy; M. Jules Ferry, Prime Minister; M. Léon Say, President of the Senate; M. Becquerel and other members of the Academy of Sciences and a great number of engineers. One of the most extraordinary experiments was the transmission of speech on a single wire from Tours to Brest, the length of which exceeded 800 miles. One Leclanché element was the sole battery in use.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER.

The coming week will, if the weather permits, witness the resumption of pipe-laying for the water-works at Akron. The first work will be at the corner of Exchange and Main streets, and then the transverse streets will follow in rapid succession.

On the 14th inst. the Fire Department of the city of Louisiana, Mo., tested a new fire engine built by the Silsby Manufacturing Company, of Senaca Falls, New York. Thirty pounds of steam was generated in 6¼ minutes, and when the pressure had reached nearly 100 pounds, a stream was thrown from a 1¼ inch nozzle 250 feet. The test was entirely satisfactory, and the engine was accepted by the council.

C. L. Goodhue, of Goodhue & Birnie, Springfield, met the committee on water-works at Spencer, Mass., recently, and proposed to introduce water into the village from Shaw Pond on his own responsibility, if a charter can be obtained, giving the town an opportunity to take it off his hands at an appraised value at any time upon certain conditions. He anticipates quite a demand for water for domestic purposes, and would expect a large revenue from this source after two or three years. The town would only pay for what it used for fire and other purposes, the same as individuals.

At the stated meeting of the Baltimore Academy, Prof. George L. Smith spoke upon his researches into the cause of the obnoxious smell and taste of the hydrant water, as demonstrated by Dr. Froelig and himself. He thought the odor and taste proceeded mainly from the oil of decomposed crustaceans, mainly Daphnia, which were exceedingly numerous; more so now than at any former time in his recollection. In the living Daphnia a small globule of oil is found near the heart, but in the dead specimens the oil has left the animal. The great numbers of these minute creatures dying in the water give off this oil in sufficient quantities to cause the oily or putty-like taste and smell. The fact that boiling in an open vessel deprives the water of this taste and smell, in a great measure, would indicate this oil to be volatile. He recommended filtering, however, as the best remedy, and especially if some means could be devised to take up the oil in the process of filtering.

The following bids were received by the Gas Commission of this city for lighting the streets and public buildings: The New York Gaslight Company, all public lamps south of Grand street, at the rate of $18 per lamp. The Manhattan Gaslight Company, all lamps between Grand and Thirty-fourth streets, $18 per lamp. The New York Mutual Gaslight Company, a certain number of the lamps in the streets and avenues between Thirty-fourth and Sixty-fifth streets, and all the lamps in the public parks between Grand and Thirty-fourth streets, at $18 per lamp. The Metropolitan Gaslight Company, a certain number of the lamps between Thirty-fourth and Seventy-ninth streets, at $18.25 per lamp. The Municipal Gaslight Company, a certain number of the street lamps between Grand and Seventieth streets, at $20 per lamp. The Harlem Gaslight Company, all lamps between Seventy-ninth street and the Harlem River, $19.50 per lamp. The Central Gas Light Company, all lamps in the Twenty-third Ward, at $30 per lamp. The Northern Gas Light Company, a certain number of lamps in the Twenty-fourth Ward, at $38 per lamp. The Yonkers Gas Light Company, a certain number of lamps in the Twenty-fourth Ward, at $30 per lamp. The Brush Electric Light Company put in two bids for furnishing voltaic arc lights of 2,000 candle-power each throughout Wall street, Broadway, from the Battery to Forty-second street; Fifth avenue, from Fourteenth street to Forty-fifth street; Eighth avenue, from Fourteenth street to Forty-fifty street; Fourteenth street, from Third avenue to Eighth avenue; Twenty-third street, from Third avenue to Eighth avenue; Thirty-fourth street, from Third avenue to Broadway; Forty-second street, from Third avenue to Broadway, and two elevated groups of six lights of 6,000 candle-power in

Madison and Union squares for $32,000 per year. No decision was made.

ELECTRICITY.

THE ELECTRIC LIGHT IN ALBANY.—The new electric light company recently formed in Albany has made tests. The *Argus* says of it: "The present enterprise is in the nature of an experiment on the part of a few enterprising business men for the purpose of testing the light and ascertaining its cost as compared with gas. They have procured the necessary apparatus and hired a portion of the old Davidson safe works, in which has been placed a 125 horse-power engine, with two generating machines, one for running forty burners and the other sixty."

In connection with the plague of telegraph poles and the peril of underground wires it is of interest to know that the work of laying subterranean cables is proceeding favorably from Nancy to Paris. The telegraph line, as we learn from *Nature*, is composed of twelve insulated wires placed in a large tube of cast iron. For each length of 500 meters doors have been arranged so that any section can be removed and replaced without having to open the ground, which is necessary in the German system of laying the cables in a solid bed of asphalt. When the experiment shall have been fairly tried it will be in order to consider the subterranean question on this side of the Atlantic.

The method by which the Brush Electric Light Company proposes to illuminate the city of Cincinnati, if the Board of Public Works accepts the offer, is to erect towers 200 feet in height and place on top of them lamps with a capacity of from 16,000 to 18,000 candle power, and on seventy-five foot posts lamps of from 2,000 to 4,000 candle power. A central station has been established, five machines, with a total capacity of 208,000 candle power, are now being manufactured, and the company expects to be ready to commence operations within a month from this date. According to the contract the cost is to be 25 per cent. less than the price now paid for gas.

STREETS, DRAINAGE, ETC.

A bill has been pending in the New York Legislature since Jan. 28 to repave Fifth Avenue, this city. The bill provides for an appropriation of $500,000.

BRIDGES.

The Baltimore & Ohio Railroad has begun the erection of a $20,000 iron bridge to replace the wood structure over the Kokosing River at Mount Vernon, Ohio.

The contract for the iron bridge over Bascauhegan River, in Danforth, Me., has been awarded to the Corrugated Metal Company, of East Berlin, Conn. This will be the first iron bridge in the State east of Bangor.

The claims of Messrs. Schultz, Dempster and Bigelow, the first contractors for the building of the Smithfield street bridge, Pittsburgh, have been compromised for $72,000, $40,000 of which is for material which will be used in the construction of the bridge. It is expected that the new bridge will cost $400,000. Bids will be received from five or six of the leading bridge builders of the United States, and the company hope to have the bridge open for travel by Christmas. It is intended to haul cars across the bridge between the Pittsburgh & Lake Erie and Baltimore & Ohio railroads with mules, as is done over the Market street bridge, Philadelphia. The bridge will be built on the Pauli system of iron and steel, and will be the first of its kind in the country. The roadway will be supported by six piers, with the customary abutments on either bank. The first pier on the north side and the two piers next to the south bank will be of comparatively small size, and to a great measure hidden from view. The three channel piers, however, will be of great size and strength, extending about fifty-two feet above high water mark, the same as the Panhandle railroad bridge. The approaches to the channel piers from either bank will be built in the usual style of ordinary truss bridges, but the part between the three channel piers will be quite different in plan. Towers twenty-five feet in height will be erected on each pier, and support a system of links and stays similar to that of the Point bridge. The intention is to have the supports of this portion of the structure above the roadway, in order to allow a free passage for high craft on the river. The channel spans will be each 360 feet in length, and the approaches will consist of plate girder spans. The abutment walls will be built of Homewood stone, with rockface finish and cut stone coping. The bridge will be for foot and wagon travel only, having no arrangement for railway traffic.

RAILROADS.

The engineers are busy looking for an easy grade up Big Creek, Ohio, for a new railroad, with strong probability of finding one.

A Duluth special says the contract for nine miles of the Northern Pacific extension eastward has been let, the work to be completed by August next.

It has been finally arranged to push the joint line of the Chicago, Burlington & Quincy and the Wabash roads from Humiston to Shenandoah at once.

About a million and a half of the two millions of stock of the projected Pittsburgh, Youngstown & Chicago Railway was subscribed at Youngstown. The survey has begun.

A corps of engineers has commenced a preliminary survey for the proposed New York, Chicago & St. Louis Railroad. They started on the Valley Railroad at what is called the five-mile lock in Cleveland.

Work on the Southern Maryland Railroad, which connects Washington, D. C., with Point Lookout, Md., is being rapidly pushed; nearly the whole road has been graded, and workmen are now vigorously at work laying ties and rails. The road will be completed for summer business.

A Des Moines despatch says: "The Wabash has purchased a strip of land eighty feet wide through the entire city for a railroad right of way. The amount paid is estimated at not less than $100,000. The track will run one block nearer the centre of the city than the Rock Island, and parallel to it."

SHREVEPORT, La., March 30.—It is reported that the Vicksburg, Shreveport & Texas Railway has been purchased by Thomas A. Scott. The purchase, it is said, needs only the ratification of the Board of Directors of the Texas & Pacific Company, which meets next month. The road is to be completed in eighteen months.

HAGERSTOWN, Md., March 28.—This evening the last spike was driven at Luray, completing the Shenandoah Valley Railroad from Hagerstown to Waynesboro, Va., where it connects with the Chesapeake & Ohio Road. The completion of this road establishes a new and independent line for business between the Atlantic seaboard, Western and Southwestern points. Through trains will be running from Hagerstown to Waynesboro, Va., by April 15.

During 1880, 161¾ miles of the Iron Mountain track were laid with steel rails. This work is still going on, and already this year 7,000 tons of steel rails have been received and 10,000 tons more are to be delivered before Sept. 1. Before the end of the year the main line between St. Louis and Texarkana will have been laid with new steel rails, sixty pounds to the yard, with heavy angle plates. The road-bed will be ballasted with gravel and broken stone and put in thorough order. About 75 miles on the Belmont line will also be laid this year with steel rails.

The St. Johnsbury & Lake Champlain Railroad, reorganized last summer, is to extend from Maquam, Vt., to Rouse's Point, N. Y., to connect with the Ogdensburg & Lake Champlain, a controlling interest in which stock has been secured by parties in the interest of the Passumpsic and St. Johnsbury and Lake Champlain roads. This, it is expected, will divert the business of the Ogdensburg & Lake Champlain road from its present route by way of the Central Vermont and Fitchburg lines to a route by way of the Passumpsic and Boston and Lowell roads. The extension referred to is to be finished by July 1 next.

DENVER, Col., March 30.—The Denver & New Orleans Railroad Company has ordered fifty miles of steel rails to be manufactured and shipped from Liverpool as soon as possible. They also closed a contract with a construction company for building the entire line from Denver to its connection with the Texas railroads in Northwestern Texas. President Evans goes East in a few days to place the remaining half million of stock of the construction company, the million allotted to Denver having all been subscribed and the first installment of 10 per cent. paid in. The president is also authorized to purchase the necessary rolling stock.

Mr. C. R. Moore, chief engineer of the Boston, Hoosac Tunnel & Western Railroad Company, has filed maps of the proposed route through the counties of Oneida, Madison and Onondaga, and the city of Syracuse, of the Utica & Syracuse "Air Line" division of the road. They are made in elegant and expensive style, and make a cumbersome book. The maps are drawn to a scale of two hundred feet to the inch. The profiles are on a scale of four hundred feet horizontal and thirty feet vertical. The line enters Utica from the east, near the driving park, follows Bleecker street to Fayette street, thence along the bank of the Chenango canal to Sauquoit creek. The route is surveyed from Syracute eastward, and from Oneida to Utica takes about the same line as the route surveyed for the New York, West Shore & Chicago Railroad. It does not pass over the same identical pieces of ground, but in places runs parallel with it. It leaves out Rome, and goes through the same towns and villages as that road, and in addition touches New Hartford. Through Utica its route is different.

RIVERS AND HARBORS.

Congress appropriated in 1880 and this year $15,000 and $10,000 respectively for the improvement of Flushing Bay, in addition to $20,000 already expended in dyking. In compliance with the unanimous request of the citizens General Newton, who has charge of the work, has abandoned the dyking, and to-day will begin dredging the bay and creek. The channel is to be deepened so as to allow vessels to come in at all stages of the tide.

CANALS.

A committee of the Board of Aldermen of this city at its last meeting reported favorably a resolution to request the Legislature to lengthen the locks of the Erie Canal by the use of iron lock gates, in order that boats carrying 11,000 bushels of grain might pass through. This was adopted by the Board. The gates proposed to be used are patented. Some of those conversant with the navigation of the canal are curious to know why the same end could not be obtained by lengthening the locks and using the present gates.

At the request of the Merchants and Manufacturers' Association, of Baltimore, and others, a bill was introduced in the Delaware Legislature, on the 30th ult., giving the right of way for a ship canal across the State anywhere below Appoquinimink Creek. Charters for the Choptank, Sassafras and Queenstown routes were previously granted, but the possibility of some other routes being selected by the commission to be appointed by President Garfield makes further action by the present Legislature advisable. The bill introduced names Congressman Martin, Governor Hall and other prominent Delawarians, and John E. Hurst, Henry C. Smith, William H. Baldwin, William T. Dickson and Joseph E. Bruff, of Maryland, corporators, with a capital stock of $30,000,000, and provides for the cession of their authority to the United States Government whenever it shall undertake to construct the canal.

NEW PROJECTS.

Work was begun on Monday at Brandywine, Md., on the Southern Maryland Railroad.

The Chicago and Northwestern has dispatched engineers to survey a route for a new railroad from Florence to the Iron River district in the upper Michigan peninsular. The length of the branch will be 20 miles.

MILWAUKEE, March 25.—Articles of association of the Great Northern Timber-Belt Railroad Company, capital $2,500,000, have been filed with the Secretary of State. The line will run from Green Bay to St. Croix River.

Articles of incorporation of the Stillwater, Hastings & Rochester Railway have been filed in Minnesota. The road purposes to run from Stillwater through Hastings to Rochester. The capital stock is fixed at $150,000, divided into shares of $100 each.

The survey of the route for the proposed new Northern Railroad of Long Island, to run from Astoria to Northport, was begun last Saturday morning, under the supervision of J. C. Lane, a civil engineer of New York, assisted by G. A. Roullier, a civil engineer of Flushing.

An order in the Canadian Council was passed Thursday, granting to the Manitoba Southwestern Railway about 2,000,000 acres of land, equal to 6,400 acres per mile. This land is described by Prof. Macoun, government botanist and explorer, as being some of the richest land in the Northwest.

Ex-Senator Gordon is represented as saying that work will be commenced at an early day on the Georgia Western road, which is to extend westward from Atlanta, Ga., through the Alabama coal fields. The road will first be built to Birmingham, Ala., to connect with the Southern & Northern, thence to be extended to the Mississippi River.

Articles of incorporation of the Stillwater, Hastings & Rochester Railway Company have been formed at St. Paul, Minn. The said road purposes to run from some point in the city of Stillwater southeasterly through Hastings to some point at or near Rochester. The capital stock is fixed at $150,000, divided into shares of $100 each.

The South Bend Southern Railway Company has filed articles of association with the State Secretary at Indianapolis. The road will run from South Bend to Plymouth, length 23 miles; capital, $220,000; directors, Clem Studebaker, Schuyler Colfax, James Oliver, Alexis Coquillard, J. M. Studebaker, John G. Birdsell, John C. Knoblock, Joseph D. Oliver, William D. George, Joseph Warden, Peter E. Studebaker, Jacob F. Studebaker and William Mack.

A map of the Brooklyn, Fort Hamilton and Coney Island Railroad has been filed in the Register's Office. The route is in the town of New Utrecht, beginning at the city line, at Sixty-fourth street and Third avenue, and extending along Third avenue and Lexington avenue, through the village of Fort Hamilton to the New York and Brighton Beach road, with which it connects in Mill lane, near the village of Bath. It will afford communication from South Brooklyn and Fort Hamilton to Brighton Beach, and will doubtless run in connection with the steam transit, by dummy engines, now in Third avenue, from Twenty-fourth street to Fort Hamilton.

CONTRACTING, MISCELLANEOUS, ETC.

The Flint & Pere Marquette road has contracted with the Detroit Dry Dock Company, of Wyandotte, to have built three iron propellers. These vessels are to run between Milwaukee and Ludington, and will be 900 tons burden, costing $120,000 each.

A movement is on foot to enlarge the Kingston Dry Dock, Canada, to double its present size. The government has promised similar assistance to that given to the Halifax Dry Dock. The change is rendered necessary by the enlargement of the Welland Canal, which will bring to that port a larger class of vessels than heretofore.

The new monster passenger engine No. 10, which is to make a revolution in railroad travel, was run into the round-house in West Philadelphia a few nights ago. She is 62 feet long, weighs 97,000 pounds and is equipped with 18-inch cylinders and four 6½-feet driving wheels. The engine did her first work bringing the Pacific express from Altoona to Harrisburg. At the latter point the engine was transferred to the St. Louis day express, that train being faster than the Pacific. The run from Harrisburg to Philadelphia, 110 miles, was made in two hours and fifty-two minutes, the train arriving on time sharp. The engine worked beautifully and the crowd of engineers who came down on her were greatly pleased with her speed and the new steam reversing arrangement. It is intended to put her on the 7:35 a.m. train between Philadelphia and New York, and it is expected she will make the fastest time ever known, ninety minutes being the figures named by the confident railroad folks.